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phosphates and phosphatic marls are of great use to the farmer in the vicinity. The purely calcareous marls are discussed, and their value shown. The clays for pottery, brick and tile making are also briefly treated, and some of them are shown to be of good quality.

Dr. Smith's work has been carried on unostentatiously for many years. The present volume is not the first piece of good work which he has done. The large results which he has brought out are altogether incommensurate with the meager appropriations which have been at his disposal. While the co-operation of the United States Survey has been of much service to his work, a service which he fully acknowledges, much credit still belongs to the state geologist himself.

ROLLIN D. SALISBURY.

Dr. K. v. Chrustschoff, Ueber Holokrystalline Makrovariolitische Gesteine. Memoires de L'Academie Imperiale des Sciences de St. Petersbourg, VII. Série, Tome XLII., No. 3. St. Petersbourg, 1894. 4to, 244 pp., 3 plates and 37 figures.

The author in his introduction refers to the work already done on the subject, and shows how in the case of the true variolite ("an endomorphic contact phenomenon of diabase") the consideration of the origin is simple in comparison with the genetic history of the orbicular structure in holocrystalline, eugranitic, plutonic rocks. The origin of these are entirely different.

Finding the references to these holocrystalline orbicular rocks to be unavailable he collected them and presents a bibliography of the special studies on spheroidal building, orbicular granites, diorites, gabbros, and diabases.

As the most direct means of approaching the subject Chrustschoff chooses six of the more noted occurrences of variolitic rocks, along with four new occurrences (two in Sweden, one in Silesia, and one in Siberia), making ten, which serve as the subject of discussion for the volume. With each example the author carefully analyses the varioles into an inner core (kern) and various concentric rims (calotte) which may or may not possess radial arrangements in conjunction with their neighbors. The mass of the rock and each of these divisions is in turn studied carefully, and the optical characteristics, order of sequence in crystallization, and very frequently the chemical composition of the various constituents are discussed in detail.

Considered separately the author reaches the following conclusions:

1. Variolitic granite from Altai, Siberia (new locality).

The chemical and mineralogical compositions of the granite magma, the core and the shells of the varioles are such that they show that here is an endogenous contact formation, since the core is more basic and does not belong to the granite magma. Judging from the zircons[1] the core "is the last remnant of an inclusion of the nature of biotite-gneiss resorbed by the granite." Further, "as when a crystal of a salt is suspended in a saturated solution of salts the salt, like the crystal, is the first precipitated and then the others, so if orthoclase were caught up in the magma the orthoclase of the magma would crystallize first, then the isomorphous plagioclase." By this time the feldspar exerts only a directing influence, so that the biotite crystallizes and is oriented with regard to the feldspar interior.

2. Variolitic amphibole-granite from Rattlesnake Bar, California.[2]

The dark green rock which contains the spheroids consists of a granular mass of cloudy gray feldspar, pellucid quartz, and abundant brownish green hornblende. The varioles are more or less regular ellipsoids with diameters of 8 cm., 5 cm., 6.5 cm. respectively, and represent basic inclusions of a foreign rock, or a more basic primary secretion from the amphibole-granite magma, which have been resorbed in part by the magma. As the cooling, pressure, water contents, etc., changed, a new crystallization took place about the included remnant forming a concentric layer of minerals produced from the preëxisting magma saturated with the included substance. This action continued until the circumstances existing in ordinary granitic formations had gained the upper hand.

The spheroidal form tends towards a more rapid crystallization, and so the secretion of concentric layers follows more rapidly than the individualization of the surrounding granitic magma. From the already formed core go out certain directing influences so that the amphibole, the ores, and part of the feldspar force themselves into a radial arrangement.

3. Variolitic granite from Kunnersdorf, Silesia (new locality).

The granite mass, in which the 8–15 cm., rounded to angular spheroids lie, consists of reddish gray, medium fine-grained feldspar, quartz, silver-gray muscovite, and biotite. The spheroids were formed in the following way:

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[1] Vid. CHRUSTSCHOFF, Zur Kenntniss der Zirkone in Gesteine. Tschermak's Min. und Petr. Mitth. Bd. XII., p. 423.

[2] VOM RATH: Sitzungber. d. niederrh. Ges., December, 1884.

During the eruption of the granitic magma fragments of a foreign granitic rock were surrounded by the granitic magma. The solid granite may have been "foreign" or it may have been from the already solidified portions of the magma. Resorption began and continued until the magma was supersaturated and the temperature lowered to a point where a new crystallization could begin.

The included granite consisted of orthoclase phenocrysts in a fine-grained groundmass which was more readily dissolvable than the compact feldspar. Though the phenocrysts did not remain entirely unattacked they were not completely resorbed, and an outer mixed zone was formed between them and the individualized magma. The subsequent crystallization took place in the mixed zone under the orienting influence of the feldspar. At the moment when crystallization reached the outer zone of influence the whole magma crystallized to a panidiomorphic-granular mixture.

In this case, as in the first, the character of the zircons proved a valuable aid in the interpretation of the varioles' genesis. The main mass and the core carried zircons of different habits, while the shell of the variole carried both types.

4. Variolititic granite from Ghistorrai near Fonni, Sardinia.

As in the cases above cited fragments of different rocks were surrounded and taken into the granitic magma, where their constituents were disassociated and in part resorbed. From this simple proposition it would seem that the rocks under consideration would be other than rare; there are, however, certain conditions essential to "kugelbildung."

"The inclusions must be concentrated within the predominant rock magma to the smallest possible space so that between them a relatively small amount of magma remains included. The enclosing part of the magma then enters into an exchange with the inclusion, and there is established corrosion, resorption, and recrystallization, though the magma may circulate very slowly between them, *e. g.*, bringing in from without and distributing from within. In consequence of this action the mixed zone supersaturated with material from the inclusion may remain stationary a long time. Under such circumstances a rapid crystallization tending towards a radial structure may set in more readily than in homogeneous granite where the crystallizing conditions naturally must be distributed equally." P. 129.

5. Variolitic specimen from Amtensee, Grythyttau, Orebrö, Sweden (new locality).

A careful petrographic description is given, but the material was insufficient for a study of its genesis.

6. "Pudding granite" from Craftsbury, Vermont.

"This is a biotite-muscovite-granite which contains concretions of biotite that are quite uniform in size and usually about an inch and a half in diameter. They are spherical or spheroidal in form and corrugated on the surface."[1]

Here Chrustschoff considers that the development of the variole falls into the period of the development of the mica in the host and the spheroids appear to be developed through the local increase of a character inherent in the entire mass; in the variole the quartz-feldspar complex is surrounded by a zone of mica broader and thicker than in the homogeneous rock. The whole phenomenon is considered as the result of concretionary action.

7. Feldspathic variole from Aldersbäck, Sweden (new locality).

The sum of the observations indicates that this variole is a resorption residue of a holocrystalline, macrovariolitic rock.

8. Variolitic quartz-diorite from Svartdal, Norway.

Here the ores and apatite balled into a glomero-porphyritic mass served as a center of crystallization so that the rock is "consequently determined as an original macrovariolitic quartz-mica-dioritic, whose spherulitic form of structure is autogenetic and due to the constitution, as well as to the mode of solidification, of the magma." P. 177.

9. Variolitic gabbro from Romsas, Askim, Norway.

The varioles were local developments along the sides of a laccolitic mass and were mechanically disseminated, locally, through the mass. The varioles crystallized under intratelluric conditions and subsequently had formed about them a rim of amphibole.

10. Variolitic amphibole-granite from Slattmossa, Sweden.[2]

Here the core is more basic than the mother rock, and we thus conclude that it is an old basic secretion around which have been formed shells of intermediate acidity. This rock, consequently, is not an original macrovariolite, but is the product of an early secretion of basic material.

The above résumé of the results and conclusions reached shows that macrovariolitic rocks belong genetically to at least four classes:

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[1] HAWES, Lithology and Mineralogy of New Hampshire, Vol. II., Part IV., p. 203.

[2] HOLST, Geol. Foren., Stockholm, Forhandlung, Bd. VII., p. 135.

1) Those of concentric spheroidal form produced by foreign inclusions.
2) Those where the varioles were formed by the partial resorption of fragments of the locally solidified magma.
3) The so-called "pudding granites," due to a concretionary action.
4) Those varioles which are primary structural forms of the magma, or are due to endomorphic contact action.

The *conditions* requisite for the formation of varioles are:

1) A difference in the basicity within the magma.
2) The cores must be near each other.
3) There must be a difference in temperature between the core and the magma.
4) The temperature must be high enough to aid resorption but not sufficient to permit the complete resorption of the fragments.

While the work is occupied primarily with a study of the origin of macrovariolitic rocks, it is full of incidental studies of the minerals encountered. This is especially true of zircon, the feldspars, and perthitic intergrowths, while there are many suggestive points on phenomena frequently seen in quartz, apatite, hornblende, etc. On the whole the work is an example of a careful, exhaustive study of a circumscribed problem.

EDWARD B. MATHEWS.

On the Banded Structure of Some Tertiary Gabbros in the Isle of Skye. By SIR ARCHIBALD GEIKIE and J. J. H. TEALL. Quart. Jour. Geol. Soc., November, 1894. Vol. I., pp, 645–659. Pls. XXVI., XXVII., XXVIII.

THE importance of this study of the Tertiary gabbros of Skye is twofold, as pointed out by the author: First, as a contribution to our knowledge of the structures which may be assumed by igneous rocks at the time of their solidification, or prior to their consolidation. Second, as an aid to the elucidation of some of the most perplexing problems in the study of the crystalline schists.

The rocks described are part of the volcanic complex which forms the picturesque group of mountains known as the Cuillin Hills in the southern portion of the Isle of Skye — a vast aggregation of indurated tuffs, agglomerates, lava-flows, besides intruded bodies that have broken